LIPIDS AND BONE (480.1-480.7)

480.1

Effect of Monounsaturated Fatty Acids on Insulin-like Growth Factor System Components in Healthy Adults.

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Together, cardiovascular disease (CVD) and osteoporosis account for most morbidity and mortality in our aging population. Recent evidence suggests these diseases share an etiologic factor in that hyperlipidemia contributes not only to atherosclerosis, but also osteoporosis. In vitro studies have shown that dietary fat modify bone biology by influencing bone cell activity. The effect of specific fatty acids on bone growth factors such as insulin-like growth factor (IGF) and their binding proteins in humans has not been explored. We conducted a human feeding study (n=23) in which healthy adults were fed either a AHA Step I diet or a monounsaturated (MUFA) rich diet (accomplished by replacing 20% of energy of the Step I diet with MUFA rich pecan nuts) for 4 weeks each in a randomized crossover design. Percent energy from MUFA in the Step I diet and MUFA rich diet were 11% and 18.9%, respectively. In this study the MUFA rich diet demonstrated a favorable impact on blood lipids and lipoproteins (published). We also determined the effect of the Step I and MUFA rich diets on IGF-I, IGF-II and IGF-binding proteins-3, -4 and -5. MUFA rich diet did not significantly alter any of the IGF system components compared to the Step I diet. Our results suggest that monounsaturated fatty acids may not have a direct role in influencing IGF system components and thus the bone turnover in humans. Further study is needed to confirm these findings. Funded in part by National Pecan Shellers Assoc.

480.2

Soy Protein and N-3 Fatty Acids Prevent Receptor Activator of NF-kB Ligand (RANKL) Expression and Osteoporosis in Ovariectomized Mice

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The source of dietary protein (animal vs vegetable) is known to alter osteoporosis in humans and in ovariectomized (OVX) animals. However, the interaction of n-6 (corn oil, CO) and n-3 (fish oil, FO) fatty acids with animal (casein, CP) and vegetable (soy protein, SP) protein based diets in modulating bone mineral density (BMD) in OVX mice has not been studied. Furthermore, n-3 fatty acids are known to act against cardiovascular and autoimmune diseases and osteoporosis in animals and humans. Weanling Balb/C mice were fed the following 4 diets 1) CP (14%) + CO (10%), 2) CP (14%) + FO (10%), 3) SP (Sigma, 14%) + CO (10%), or 4) SP (14%) + FO (10%). Two months later sham surgery or OVX was performed. After 4 mo., BMD was measured using DEXA (PIXImus II) and mice were killed. Significant bone loss (20%) in the distal left femur of CP + CO OVX mice correlated with high RANKL expression ($p<0.05$) in T cells, whereas SP + CO mice lost 13%. CP and SP, FO fed mice lost 10% and 4% BMD compared to sham and RANKL remained low. BMD was significantly higher in CP than in SP sham mice but BMD loss and RANKL were less in SP OVX mice. SP and FO may have synergistic effects in preventing BMD loss in OVX mice. (Supported by NIH AG-14541)

480.3

Feeding fish oil during growth does not alter bone mass or serum insulin-like growth factor-1 (IGF-1) in male and female rats

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Omega-3 long chain polyunsaturated fatty acids (LCPUFAs) can modulate bone modeling. The objective of this study was to determine the effect of a diet rich in omega-3 LCPUFAs on bone development. Male and female rats (n=9-12/diet/gender) were randomized to a control or fish oil diet from weaning (postnatal day (PND) 21) until necropsy (PND 56). Diets differed only in fat profile: control (7% soybean oil) or fish oil (6% menhaden oil + 1% soybean oil). Body weight and length were measured at PND 21 and PND 56. Bone mineral content (BMC) and density (BMD) of femurs and spines (L1-L6) were measured by dual energy x-ray absorptiometry (Hologic QDR4500). Femur and tibia size was measured using digital calipers. Serum IGF-1 was measured by radioimmunoassay. While fish oil did not affect weight gain, females fed the fish oil diet had lower food intakes ($p=0.022$) and experienced a marginal reduction ($p=0.049$) in length growth compared to controls. Femur and tibia size, femur and spine BMC and BMD, and serum IGF-1 were not different between groups within genders. While BMC and BMD were not affected by fish oil, biomechanical bone strength will be measured to determine if a diet high in omega-3 LCPUFAs alters fracture resistance. (NSERC Scholarship to IS).

480.4

High-fat Diets Reduce Bone Biomechanical Properties in Aged Rats

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Dietary factors are known to play an important role in the mediation of bone fracture risk. The present study investigated the effects of amount and type of dietary fat on bone biomechanical properties in an aged rodent model. F344BNF1/NIA male rats (n=108, 23 mo. at the start of the study) were matched for body weight and food intake, and assigned to one of six dietary groups. Diets were nutritionally controlled and intakes were yoked across the 20-wk study. Diets contained either vegetable shortening or borage oil at three levels (10%, 40% and 78%). After 20 wk., rats were euthanized and the right tibias were removed and assayed for biomechanical properties. Significant reductions in load at yield, work to yield, maximum load, and stiffness occurred when high-fat diets were consumed ($p<0.05$). The type of fat consumed had no significant effect. These results demonstrate that high-fat diets can have negative effects on bone biomechanical properties in aged rats. This suggests that the amount of fat consumed may be an important factor influencing fracture risk. Supported by RO3-AG17711.

480.5

Fat Intake and Bone Health in NHANES III.

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Animal studies suggest that fat intake and bone density may be inversely related. This study used NHANES III data (n=14,850) to assess the relation of dietary fat to bone mineral content (BMC) and density (BMD) in the femur neck, intertrochanter, trochanter and total hip. Multivariate models using SAS-callable SUDAAN were used to adjust for the sampling scheme. Dietary variables were energy-adjusted by the residual method. Total fat intake was negatively associated with BMC and BMD at several sites. Further, the relationships were stronger for saturated fat, males and younger individuals. Analysis of covariance was used to generate mean BMC and BMD by quintile of saturated fat after adjusting for height, weight, age, race, smoking, energy and calcium intake, and hormonal use for 4 gender/age groups. The greatest effects were seen among men < 50 yrs. For the femur neck, adjusted mean BMC and BMD were 3.5% and 4.3% less among men with the highest compared to the lowest quintile of saturated fat intake. These data suggest that BMC and BMD are negatively associated with total and saturated fat intake, and that males may be particularly vulnerable to these effects. Funded by PSU Gerontology Center.

480.6

Effect of Corn Oil (n-6) and Fish Oil (n-3) on Bone Mineral Density in Young and Old Mice

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Bone loss during aging is a major health and economic burden in our fast growing elderly population. Recent studies indicate that n-3 fatty acid supplements provide benefits against cardiovascular and autoimmune disorders. A few studies indicate that n-3 fatty acids prevent bone loss in ovariectomized rats and in menopausal women. The present study was carried out in C57BL/6 female mice maintained on an AIN-76 diet supplemented with either 5% corn oil or 5% fish oil from 6 weeks onwards. Bone mineral density (BMD) was measured by dual energy x-ray absoptiometry (PIXImus) in young, 6 month-old mice and compared to 16 month-old mice. The results revealed that at 6 mo, FO fed mice had